

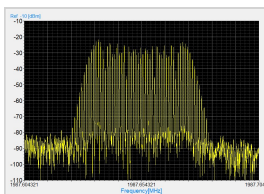
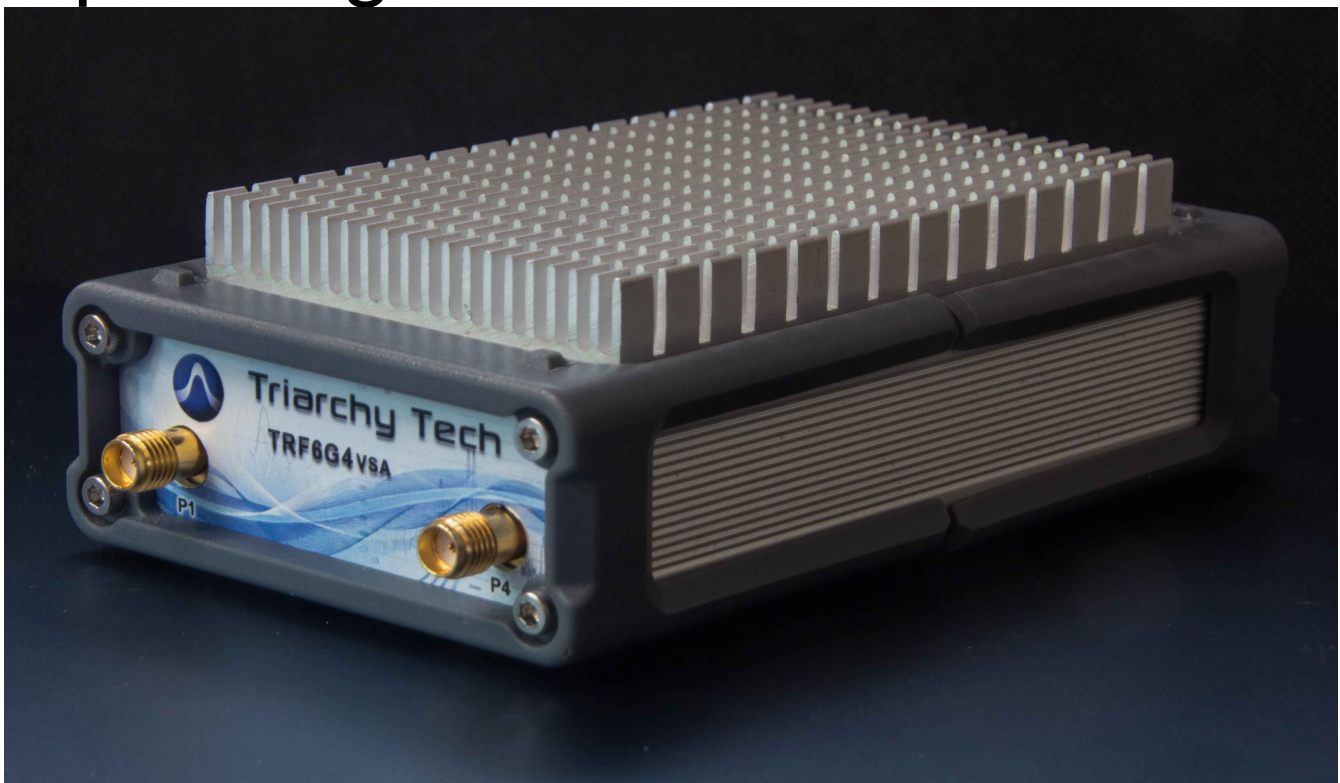


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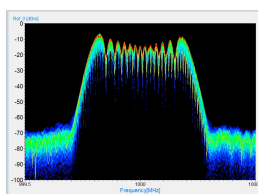
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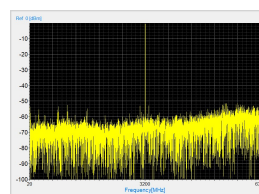
Triarchy®TRF6G4vsa USB Vector Spectrum analyzer Operating Manual



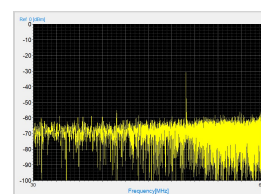
FFT freq Sweep



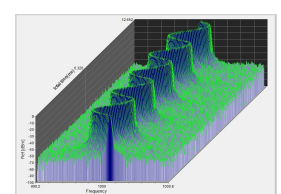
FM signal with Density



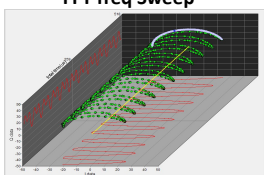
Full SPAN



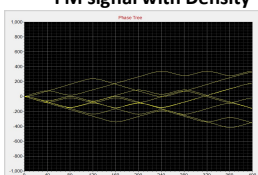
HB Log Sweep



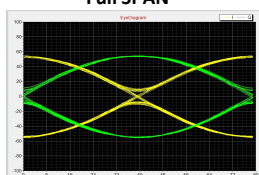
FM shown by STFT (Amp)



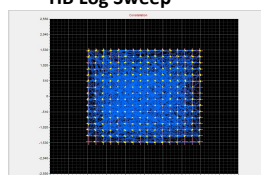
PM Shown by STFT (phase)



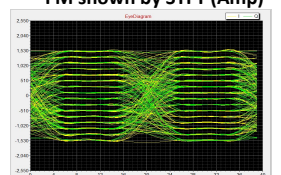
GMSK phase tree



GMSK eyes diagram



256QAM constellation



256QAM eyes diagram



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USB Vector Spectrum Analyzer Operating Manual

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Initial Version October 2026

Documentation version 1.0

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1 Introduction

The **TRF6G4vsa** is a compact USB-based vector spectrum analyzer designed to operate with a PC while delivering true spectrum-analyzer performance. With a 144 MSPS ADC, it provides a 70 MHz real-time bandwidth and an SFDR of approximately 70 dB, giving it measurement capability comparable to many benchtop analyzers.

In addition to standard spectrum-analysis capabilities, the TRF6G4vsa provides several advanced functions, including Log Frequency Sweep for EMC pre-compliance evaluation, STFT analysis for examining modulation behavior over time, wide-range analog demodulation from a few hertz to tens of megahertz, and digital demodulation supporting both frequency-based and phase-based formats. Its digital demodulation system is highly flexible because modulation schemes can be defined through user-created I&Q files, enabling support for many different digital formats. With the ability to process digital data rates up to 20 Mbps, the TRF6G4vsa is well suited for analyzing modern communication signals.

TRF6G4vsa also make spectrum analyzer LO port into simple RF signal generator, RF signal level can be change from 10dBm to-70dBm, it also has frequency sweep mode, amplitude sweep mode, frequency hopping mode, pulse modulation. Pulse signal can be directly output to AUX1 port as simple pulse signal generator.

1.1 TRF6G4vsa Product Package Overview

TRF6G4vsa product package will be:

- | | |
|--------------------------------------|-----------|
| 1: USB spectrum device (20x65x115mm) | one piece |
| 2: USB Type C cable | one piece |
| 3: 200x110x45mm product case | one piece |

1.2 USB Device Overview



Fig1: device front panel

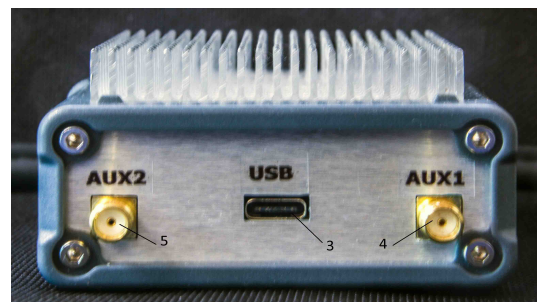
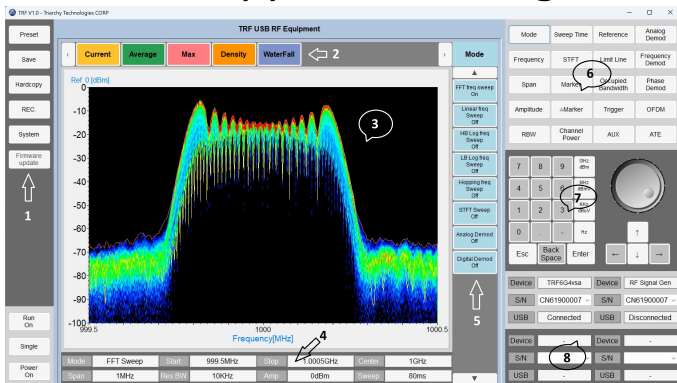


Fig.2 device rear panel

- | | | |
|------------------|------------------------|--|
| 1: RF output P1 | SMA connector (female) | RF signal generator output |
| 2: RF output P4 | SMA connector (female) | RF spectrum analyzer input |
| 3: USB connector | USB Type C connector | interface with PC |
| 4: AUX1 | SMA connector (female) | ref Clock output and other functional pins |
| 5: AUX2 | SMA connector (female) | ref Clock input and other functional pin |



1.3 TRF PC Application Program Overview



Dig.3 Spectrum analyzer Keys group

1: System keys

Allows user to access the system level function, Function detail will be shown on second function keys.

Preset: 6 preset key and custom key can be used to resume the pre setting which is saved operation setting by Save key, default key will make spectrum go into default setting. The Last will resume to setting to last time when device plug off from PC

Save: To save the spectrum analyzer all the setting into SET folder which will be used by preset key

Hardcopy: Save the main display image into hardcopy folder.

Record: reserve to record function, this function is not working now.

Config: freq offset will fine turn Main clock 24MHz frequency, Density decay will change density image persistence time.

RF ON/OFF: Using for stop spectrum analyzer scan and to change to setting each parameter value.

Single: When RF OFF, click single key to start single test.

Power ON/OFF: using for RF signal generator to turn on the RF output.

2: Display Function Keys/Spectrum Analyzer, Message selection keys/Signal Generator

Click the Message selection key, the Message display area will be followed to be changed.

3: Main Display area/spectrum analyzer, Message display area/signal Generator

Main display area will be shown the signal spectrum image or demodulation waveform.

4: Status Block

Status block will be shown the main parameter setting.

5: Second functions keys

Second function keys will be extending key, it will be followed the function keys and system key to extend function setting to more detail. It is similar to soft key in most of equipment. Most of parameter will be input from second function keys.

6: Function keys

Most of major the equipment setting will be done by **Function keys**. First, it needs to select mode which allow equipment working into different area. Then basic setting will be frequency, SPAN, Amplitude and RBW.

7: Digital input keys

Digital input keys will input digital and units for frequency, amplitude and timing. When units key is clicked, the commend is sending to USB dongle. This standalone input key is similar to desktop equipment. It will be allowed to be used in touch screen PC without keypad.

8: USB connection area

There is total four USB area in the front panel which allow four equipment can be setup in one TRF program. TRF6G4vsa have two main equipment in it: spectrum analyzer and RF signal generator.

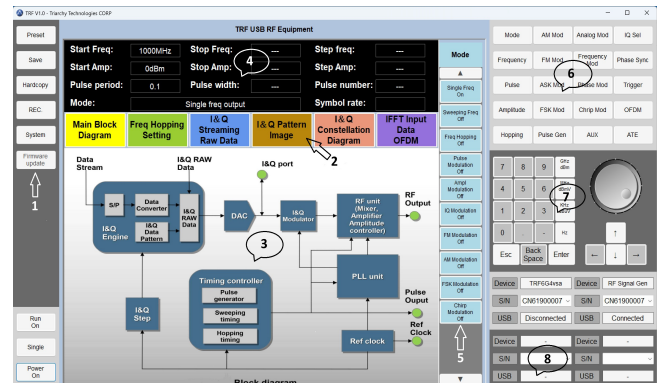


Fig.4 RF signal generator keys group

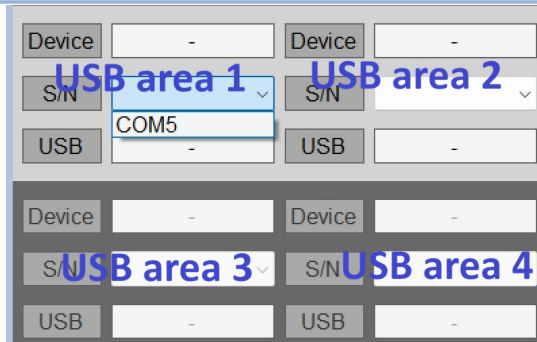


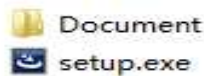
Fig.5 USB area 1 to 4

It is only one USB port as main equipment which be used to connect PC with device via USB port.
TRF6G4vsa spectrum analyzer is located at USB area 1, RF signal generator is located at USB area 2.

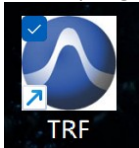
2 Getting Started

2.1 Install PC Application

Download the TRF Vx.x package from Triarchy web (www.triarchytech.com), Unzip the software package, go into the SW file folder, you can find setup.exe , please double click to setup.exe to start the installation.



When you finished the installation, the TRF ICON will be shown on the desk. Double click the TRF ICON to start TRF PC program,



After installation, the program file will be installed at program file folder.

C:\Program Files (x86)\Triarchy Tech\TRF

The application data will be generated at Document folder:

C:\Users\Username\Documents\Triarchy Tech\TRF spectrum analyzer

Customer need to check the application data at document folder.

Hardcopy folder will be stored the image file which generated by hardcopy key.

Hopping folder will be stored the hopping files.

I&Q Demodulation folder will be stored the all the demodulation file.

Setting folder will be stored the saving file, preset, and special setting can be stored in it, then using load key to resumed the special setting.



- Adapter
- Calibration
- Hardcopy
- Hopping
- I&Q Demodulation
- LimitLine
- Record
- ReferenceLine
- Settings

The customer can add more files into document folder, so that more demodulation file and Hopping file can be copied into this folder.

2.2 First Working Example

When you first time to use the TRF6G4vsa product, the TRF program shall be open first, then plug USB device into PC USB port, the COM port number will be shown on S/N block in USB area 1. See Fig.6. Then click COM port, USB device will be setup up connection, product model name will be shown Device block, Series number will be shown on S/N block, Connected will be shown on USB block, see Fig 7.

Device	-	Device	-
S/N	COM5	S/N	-
USB	-	USB	-

Fig.6 Before USB connection

Device	TRF6G4vsa	Device	RF Signal Gen
S/N	CN61900007	S/N	CN61900007
USB	Connected	USB	Disconnected

Fig.7 After USB connection

The TRF6G4vsa spectrum analyzer is working, spectrum image can be seen with default value 1GHz, see Fig.8. Click Series Number at USB area 2, RF signal generator will be working, first it need to click Power Key to ON in System, The RF signal generator will be output 1GHz signal with 0dBm. See Fig.9

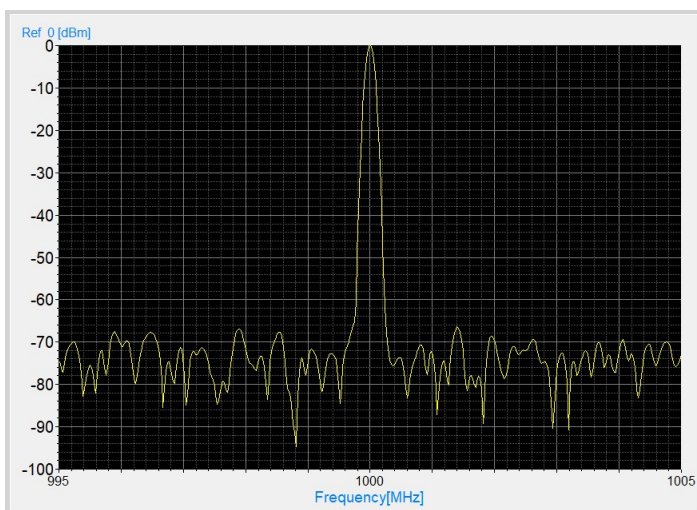


Fig.8 Spectrum default setting, 1GHz, 10MHz span, 0dBm

Start Freq:	1000MHz	Stop Freq:	---	Step freq:	---
Start Amp:	0dBm	Stop Amp:	---	Step Amp:	---
Pulse period:	0.1	Pulse width:	---	Pulse number:	---
Mode:	Single freq output		Symbol rate:		

Fig.9 RF signal default setting, 1GHz CW waveform, 0dBm



3 Operations

3.1 Setup connection for Spectrum analyzer

To begin using the TRF6G4vsa as a spectrum analyzer, first launch the TRF PC Program on your computer. Connect the device to the PC using a USB Type-C cable. Once connected, the **S/N field** in USB Zone 1 will display the detected **COM port**. Select this COM port to establish communication with the device.

After the connection is made, the device's serial number (CN619000xxx) will appear in the S/N field, the **model** name **TRF6G4vsa** will be shown, and the status will change to "**connected**." The spectrum waveform will then appear in the main display area, indicating that the TRF6G4vsa is operating in spectrum-analyzer mode.

The TRF PC Program supports multiple TRF devices at the same time. To use more than one device, simply open another instance of the TRF PC Program and plug in an additional TRF unit. A different COM port will appear in the S/N field; select it to activate the second device.

The TRF6G4vsa provides eight main spectrum-analyzer modes, selectable from the **Mode Menu**:

- FFT frequency Sweep (default setting)
- Linear frequency sweep
- HB LOG frequency sweep
- LB LOG frequency sweep
- Hopping frequency sweep
- STFT sweep
- Analog Demodulation
- Digital Demodulation

3.2 FFT freq Sweep

The FFT Frequency Sweep mode uses FFT processing to perform the spectrum sweep. In this mode, the LO frequency remains fixed and does not sweep. Instead, the sweep range is determined by the ADC sample rate. The maximum usable SPAN is half of the ADC sampling rate, because only half of the FFT band is used to avoid image spurious signals. For example, with a 144 MS/s sampling rate, the theoretical maximum SPAN is 72MHz. The TRF6G4vsa limits this to 70 MHz to reduce LO-related noise.

By adjusting the ADC sample rate, different SPAN values can be selected. In FFT Frequency Sweep mode, the TRF6G4vsa supports a SPAN range from 1 kHz to 70 MHz, and SPAN can be set to any value within this range.

Because FFT Frequency Sweep captures the spectrum in real time, it provides a very accurate representation of the instantaneous signal. This makes it especially useful for analyzing modulation signals and observing detailed demodulation behavior.

3.2.1 frequency range

In FFT Frequency Sweep mode, the TRF6G4vsa supports a frequency range from 5 kHz to 6.4 GHz. The center frequency can be set to any value within this range, with a fine tuning resolution of 0.01 Hz.

The **Low Band (LB)** covers 5 kHz to 36 MHz, where the RF signal is routed directly to the ADC through an amplitude-control circuit.

The **High Band (HB)** covers 36 MHz to 6.4 GHz, where the RF signal is first down-converted by an RF mixer before entering the ADC.

Because FFT Frequency Sweep uses a fixed LO and relies on ADC sampling, it cannot perform a full-span sweep. The maximum SPAN is limited to 70 MHz, making this mode ideal for near-band signal analysis. Image components from both



the RF mixer and the digital mixer (ADC) cannot be completely removed, even with filtering, so FFT Frequency Sweep is best suited for observing signals within a limited frequency span. For wide-range sweeping without image artifacts, **Linear Frequency Sweep** should be used.

3.2.2 SPAN range

In FFT Frequency Sweep mode, the available SPAN depends on the operating frequency band. The SPAN can always be set to any value within the allowed range, which is shown in the SPAN menu.

- For **120 MHz to 6.4 GHz**, the default SPAN is **10 MHz**, and the adjustable range is **1 kHz to 70 MHz**.
- For **36 MHz to 120 MHz**, the default SPAN is **2 MHz**, with an adjustable range of **1 kHz to 2 MHz**.
- For **1 MHz to 36 MHz**, the default SPAN is **$1.5 \times \text{Fin}$** , and the adjustable range is **140 kHz up to $1.94 \times \text{Fin}$** .
- For **5 kHz to 999 kHz**, the default SPAN is also **$1.5 \times \text{Fin}$** , and the adjustable range is **4 kHz up to $1.94 \times \text{Fin}$** .

These limits ensure stable FFT operation and help avoid interference from internal clocks.

When operating in the **36 MHz to 120 MHz** region, the measured signal may overlap with the ADC clock and main clock. To reduce this interference, the default SPAN is lowered to **2 MHz**. Some clock-related spurs may still appear at certain frequencies. The **Moving Spurs** function in the SPAN menu allows you to shift the LO clock position, helping to reduce or remove these spurious components.

3.2.3 RBW range

In FFT Frequency Sweep mode, the **default RBW** is calculated as **$\text{SPAN} \div 100$** . The RBW value automatically changes when the SPAN is adjusted, and the full allowable RBW range for each SPAN setting is shown in the **RBW menu**.

The minimum usable SPAN is **25 Hz**. In the RBW menu, the maximum selectable SPAN is **1 MHz**, but manual entry up to **10 MHz** is supported.

Setting RBW to a smaller value increases the FFT length, which results in a **longer sweep time**. This is normal behavior for FFT-based spectrum analysis.

A dedicated VBW filter is not included, as additional filtering would complicate system setup. However, the **Average** function in the display menu can be used to achieve a VBW-like effect. Selecting an appropriate averaging level will reduce display noise and produce a smoother trace.

3.2.4 One sample test for FFT frequency Sweep

To perform a basic FFT Frequency Sweep measurement, follow the steps below:

1. Select **FFT Frequency Sweep** in the Mode menu. The key will switch to **ON**, and the device enters the default FFT sweep settings: **Freq = 1 GHz**, **SPAN = 10 MHz**, **RBW = 100 kHz**, **Amplitude = 0 dBm** (see Fig. 10).
2. Open the **Frequency** menu and enter the desired measurement frequency. For example, if the input signal is a **MOD 20 kHz FM (1 kHz deviation)** at **-10 dBm**, set the frequency to **1987.654321 MHz**. Keep SPAN at **10 MHz**, and adjust the amplitude to **-10 dBm** (see Fig. 11).
3. Open the **SPAN** menu and set SPAN to **100 kHz**. The FM modulation envelope will become visible. Enabling **Max Hold** provides a stable display of the modulation spectrum (see Fig. 12).
4. Open the **RBW** menu and set RBW to **50 Hz**. With this narrow RBW, the detailed FM spectrum becomes clear, showing individual spectral lines spaced at **1 kHz** (see Fig. 13).

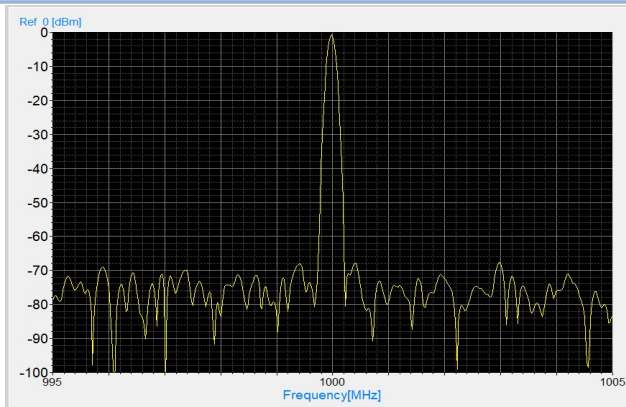


Fig.10 FFT freq sweep Default setting

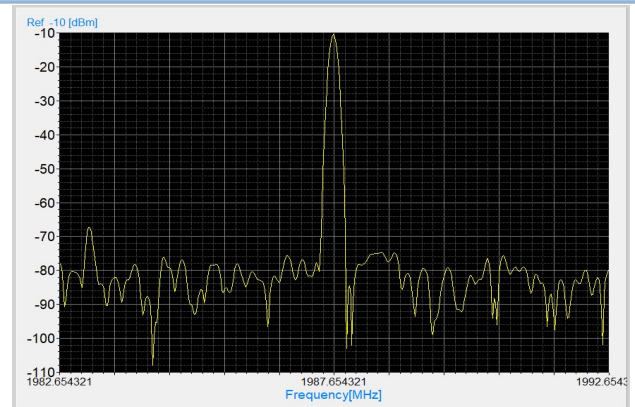


Fig.11 FM signal freq=1987.654321MHz, SPAN=10MHz

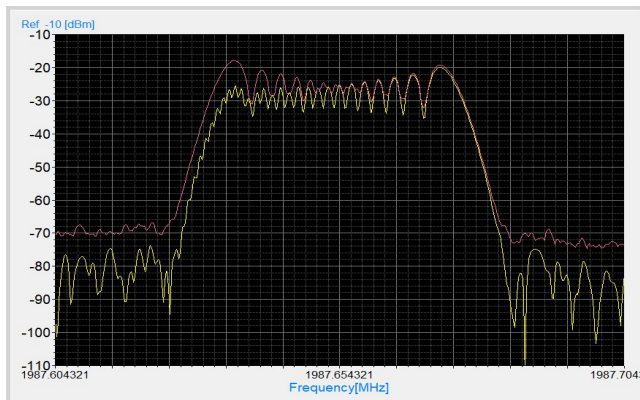


Fig.12 FM signal SPAN=100KHz, RBW=1KHz

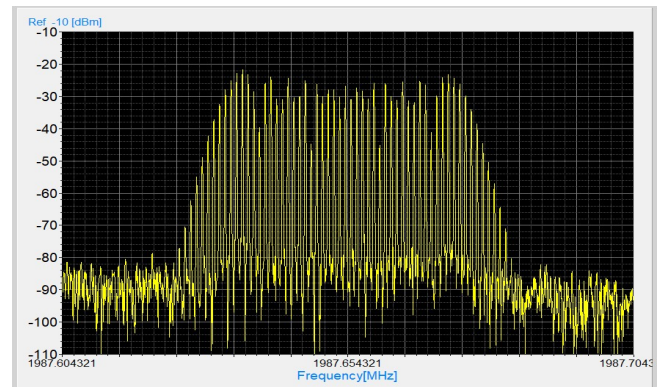


Fig.13 Singal FM SPAN=100KHz, RBW=100Hz

3.3 Linear freq Sweep

Linear Frequency Sweep combines **LO frequency sweeping** with **FFT-based sweeping**, meaning each LO step includes its own FFT segment. This approach allows the analyzer to cover a much wider frequency range than FFT sweep alone. For narrow-band measurements (≤ 30 MHz), Linear Frequency Sweep still uses multiple LO points, but it also applies a special digital filter to suppress image components and other spurious signals. Because most image artifacts are removed, Linear Frequency Sweep can operate over a very wide SPAN, including the **full span** of the instrument.

In comparison, FFT Frequency Sweep is limited to a maximum SPAN of 70 MHz, making it ideal for near-band or narrow-band signal analysis. Linear Frequency Sweep, however, can exceed 70 MHz and reach the full available span, making it the preferred mode for wide-band spectrum measurements.

In short, use **FFT Frequency Sweep** for detailed narrow-band analysis, and use **Linear Frequency Sweep** when you need to view a very wide spectrum range.

3.3.1 Frequency, SPAN and RBW range

In Linear Frequency Sweep mode, the usable frequency range is 36 MHz to 6.4 GHz, with a tuning resolution of 0.01 Hz. This mode operates only in the **High Band (HB)**.

The default SPAN is 10 MHz, but when the center frequency is between 36 MHz and 120 MHz, the system automatically reduces the default SPAN to 2 MHz to avoid clock-related spurs. The SPAN range is shown in the **SPAN menu**, and the user may select any value within that range. A **Full Span** option (20 MHz to 6380 MHz) is also available, and it is supported only in Linear Frequency Sweep mode.



The default **RBW** is calculated as **SPAN ÷ 100**. The RBW range for each SPAN setting is listed in the **RBW menu**, and RBW can be adjusted freely within that range. Note that selecting a **smaller RBW** increases FFT length and will result in **longer sweep time**.

3.3.2 One sample test for Linear frequency Sweep

To perform a basic Linear Frequency Sweep measurement:

- Select **Linear Frequency Sweep** in the Mode menu. The key switches to **ON**, and the device enters the default settings: **Freq = 1 GHz, SPAN = 10 MHz, RBW = 100 kHz, Amplitude = 0 dBm** (see Fig. 14).
- Open the **Frequency** menu. Enter **500 MHz** as the **Start Frequency** and **3.5 GHz** as the **Stop Frequency**. Click **Send** to apply the sweep range to the device (see Fig. 15).

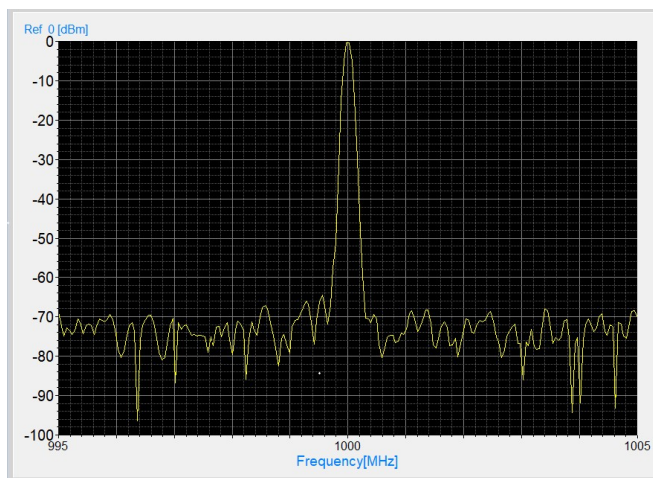


Fig.14 1GHz Signal in Linear Freq Sweep default Setting

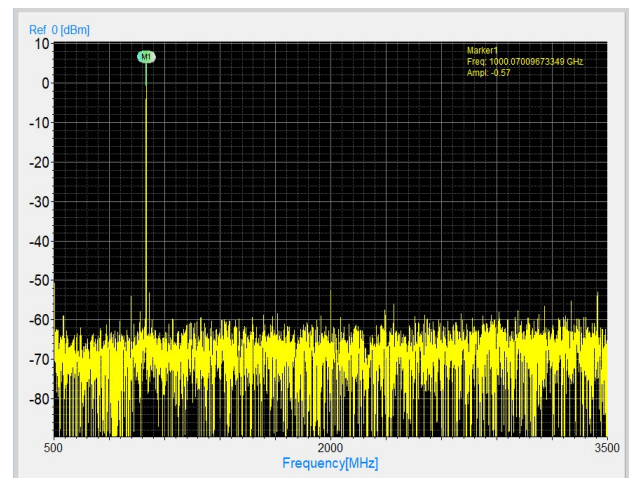


Fig.15 1GHz in Linear Freq Sweep with 3GHz SPAN

3.4 Log freq Sweep

A **Log Frequency Sweep** scans the spectrum on a logarithmic scale, giving fine resolution at low frequencies and wide coverage at high frequencies. This makes it useful for observing signals that span multiple decades of frequency.

The TRF6G4vsa provides two Log Sweep modes:

HB Log Frequency Sweep

- **Frequency Range:** 20 MHz to 6.4 GHz
- **Default Sweep Range:** 30 MHz to 6 GHz

For a sweep defined by **Start Frequency (STF)** and **Stop Frequency (SPF)**, the number of sweep points (**SFP**) is:

$$SFP = \text{INT} \left(-\frac{\log(SPF/STF)}{\log(1 - 30/SPF)} \right)$$

Each point's frequency value (**PFV**) is:

$$PFV(N) = STF \times \left(\frac{1}{1 - 30/SPF} \right)^N$$

Example: STF = 30 MHz, SPF = 1000 MHz → SFP = 115 points

PFV(0) = 30 MHz

PFV(1) = 30.928 MHz ...

PFV(115) = 996.258 MHz

LB Log Frequency Sweep

- **Frequency Range:** 5 kHz to 36 MHz
- **Default Sweep Range:** 150 kHz to 30 MHz
- **Sweep Points:** Fixed at 100



Each point's frequency value is:

$$PFV(N) = STF \times ((SPF/STF)^{0.01})^N$$

Example: STF = 20 kHz, SPF = 10 MHz $\rightarrow$ SFP = 100 points

PFV(0) = 20 kHz

PFV(1) = 20.28 kHz ...

PFV(100) = 10 MHz

3.4.1 Frequency, SPAN and RBW range

Log Frequency Sweep settings can be configured in two ways:

- **Method 1:** Enter **Start Frequency (STF)** and **Stop Frequency (SPF)** in the Frequency menu, then click **Send** to apply the sweep range to the device.
- **Method 2:** Enter the **Center Frequency** in the Frequency menu (no Send key required), then set the **SPAN** value in the SPAN menu.

RBW is available only in HB Log Sweep. The default RBW is 1 MHz, and it can be adjusted within the RBW menu's allowable range. Selecting a smaller **RBW** significantly increases sweep time.

Because HB Log Sweep requires longer processing time, changing settings while it is running can be slow. For easier configuration, click **Run** to switch it **Off**, adjust all required parameters, then click **Run** again to return it to **On**. The HB Log Sweep will resume with the updated settings.

3.4.2 One sample test for Log freq Sweep

- Select **HB Log Frequency Sweep** in the Mode menu. The key switches to **ON**, and the device enters the default HB log-sweep settings: **Start Freq = 30 MHz**, **Stop Freq = 6 GHz**, **Amplitude = 0 dBm**. The input signal in this example is **500 MHz @ -30 dBm** (see Fig. 16).
- Click **Run** to switch the sweep **Off**. The display will pause, allowing settings to be changed more easily. Enter **100 MHz** as the **Start Frequency** and **1000 MHz** as the **Stop Frequency** in the Frequency menu. Click **Send** to apply the new sweep range to the device. After all settings are arranged, click **Run** again to switch it **On**. The HB Log Frequency Sweep will resume with the updated parameters (see Fig. 17).

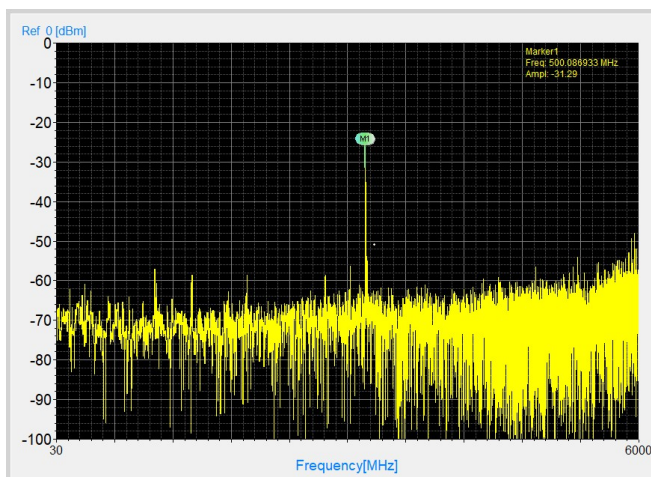


Fig.16 default HB Log Freq seeting

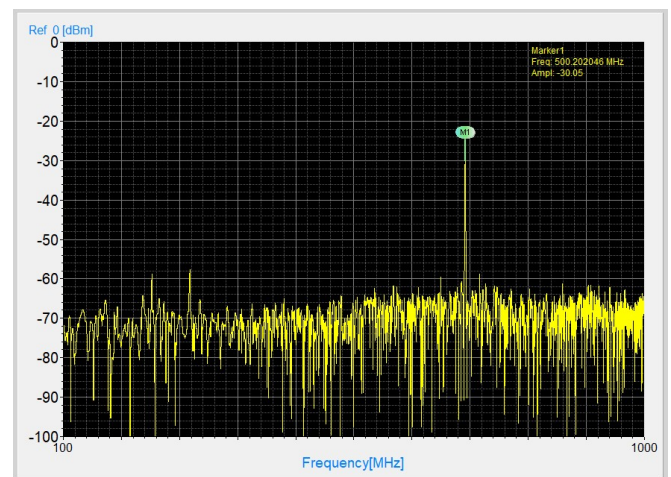


Fig.17 Start freq 100MHz, Stop freq 1GHz Log sweep



3.5 Hopping freq Sweep

A **Hopping Frequency Sweep** allows the spectrum analyzer to follow a customized sequence of frequency segments, defined by a user-created hopping file. By editing this file, the sweep pattern can be tailored for different applications or specialized test requirements.

This mode is especially useful when monitoring multiple non-contiguous frequency bands. For example, to observe activity in the 900 MHz, 2.4 GHz, and 5.8 GHz ISM bands, you can define three sweep segments:

- 902–918 MHz
- 2.40–2.48 GHz
- 5.75–5.87 GHz

The analyzer will then hop only through these ranges, allowing fast and efficient monitoring of ISM-band signals.

Hopping sweeps are also valuable for mixer testing. A mixer produces many combination frequencies at its IF output, including RF and LO leakage, $LO \pm n \cdot IF$, $RF \pm n \cdot IF$, and higher-order components such as $2 \cdot RF$ and $2 \cdot LO$. By defining sweep points at these specific frequencies, the hopping sweep can quickly evaluate mixer performance and identify unwanted spurious outputs.

3.5.1 Hopping file setup

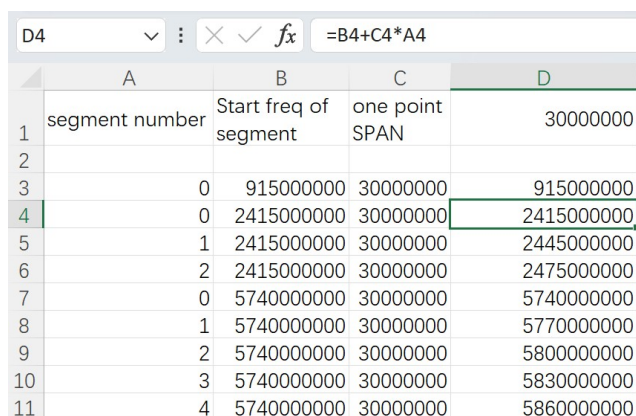
A hopping file contains two elements: a single SPAN value used for all sweep points, and a column of frequency values that the analyzer will scan one by one. The file can be prepared in Excel to calculate each required frequency point. The first item is the SPAN value (typically **30 MHz**), and every frequency point in the list uses this same SPAN. After calculating all frequency values based on the application requirements, keep only the frequency column and export it on TXT file.

For example, when monitoring ISM bands, three segments may be defined:

- **902–928 MHz**, covered with one point (e.g., 915 MHz @ 30 MHz SPAN)
- **2400–2483 MHz**, covered with three points
- **5725–5875 MHz**, covered with five points

These frequency points are placed sequentially in the hopping file. The analyzer loads the file and sweeps through each point in order, then repeats the sequence continuously. See Fig.18 and Fig.19 for more detail.

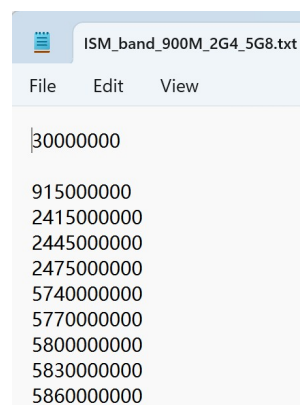
The hopping file supports **2 to 1250 frequency points**. During operation, the analyzer will hop through each frequency value one at a time. For best performance, the SPAN value in the file should remain at **30 MHz**; using a smaller SPAN may introduce spurious responses.



The Excel spreadsheet shows a table with columns A, B, C, and D. Column A is 'segment number', B is 'Start freq of segment', C is 'one point SPAN', and D is the calculated frequency. The formula bar shows '=B4+C4*A4'. The data is as follows:

	A	B	C	D
1	segment number	Start freq of segment	one point SPAN	30000000
2				
3	0	915000000	30000000	915000000
4	0	2415000000	30000000	2415000000
5	1	2415000000	30000000	2445000000
6	2	2415000000	30000000	2475000000
7	0	5740000000	30000000	5740000000
8	1	5740000000	30000000	5770000000
9	2	5740000000	30000000	5800000000
10	3	5740000000	30000000	5830000000
11	4	5740000000	30000000	5860000000

Fig.18 Excel file for calculation each frequency points



The text file 'ISM_band_900M_2G4_5G8.txt' contains the following frequency values:

```
30000000
915000000
2415000000
2445000000
2475000000
5740000000
5770000000
5800000000
5830000000
5860000000
```

Fig.19 final Hopping file in txt format

3.5.2 One sample test for Hopping freq Sweep

This example uses a **Mini-Circuits SIM-83+ passive mixer**.



- **RF input:** 2215 MHz @ 0 dBm
- **LO input:** 2000 MHz @ 7 dBm
- **Measurement port:** IF output

The hopping sweep will scan the following 20 frequency components:

- **IF (215 MHz)**
- **LO – 4×IF, LO – 3×IF, LO – 2×IF, LO – IF, LO**
- **RF, RF + IF, RF + 2×IF, RF + 3×IF, RF + 4×IF**
- **2×LO – 4×IF, 2×LO – 3×IF, 2×LO – 2×IF, 2×LO – IF, 2×LO**
- **LO + RF, 2×RF, 2×RF + IF, 2×RF + 2×IF**

These points allow the analyzer to capture all major mixer parameter, including leakage, fundamental tones, and higher-order spurs.

- Select **Hopping Frequency Sweep** in the Mode menu. The Hopping folder will open automatically. Choose the file **Mixer_RF2G215_LO2G.txt** from the list and load it (see Fig. 20).
- The hopping sweep results will appear on the main display. The IF output is the primary useful signal, measured at – **8 dBm**. With an RF input of **2215 MHz @ 0 dBm**, the mixer's insertion loss is approximately **8 dB**. All other mixer-generated frequency components will also be visible in the hopping sweep (see Fig. 21).



Fig. 20 Hopping file folder

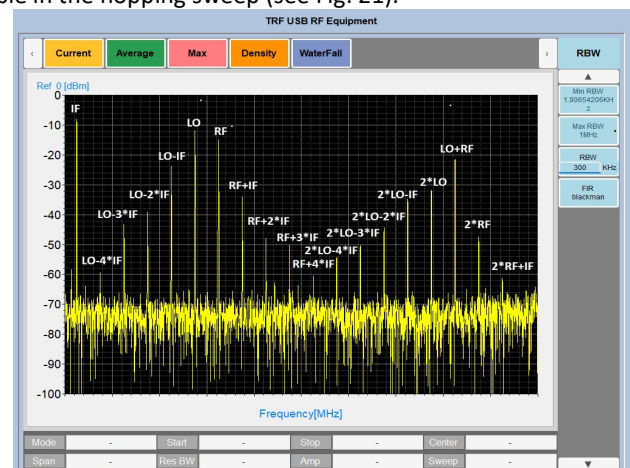


Fig. 21 Mixer test hopping freq sweep

3.6 STFT Sweep

A standard FFT shows the signal's frequency spectrum at one instant in time. This is useful for seeing the overall spectral shape, but it cannot show how the spectrum changes as the signal is being modulated. Because most modulation formats vary continuously with time, a single-moment FFT often hides important behavior.

The STFT function solves this by displaying both the **frequency** spectrum and its variation over **time**. This makes it much easier to observe how a modulation signal behaves. For example, an FM signal viewed only with FFT appears simply as a wide, spread spectrum, and you cannot see how the instantaneous frequency is changing. When viewed with STFT in the 3D display, the FM signal's frequency movement becomes clear, allowing you to easily understand how the modulation is operating. Fig.22 is FM signal shown by STFT sweep, Fig.23 is FM signal shown by FFT sweep.

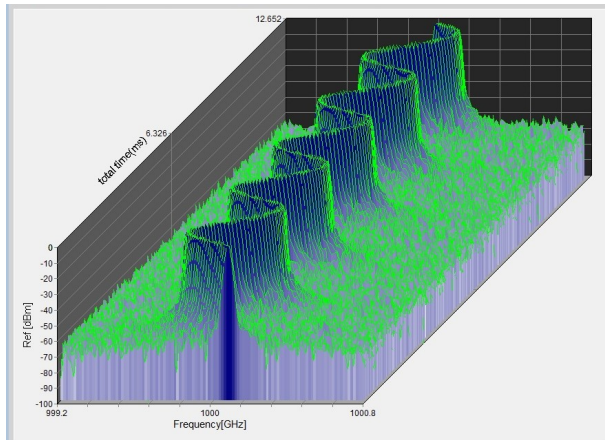


Fig.22 FM signal 200KHz dev in STFT mode

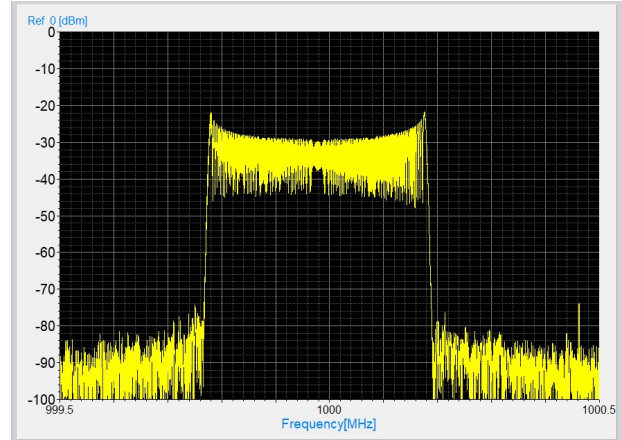


Fig.23 FM signal in FFT mode

3.6.1 STFT Magnitude

The Short-Time FFT (STFT) function converts the input time-domain signal into the frequency domain. After FFT processing, each FFT point contains two computed values: Magnitude (Amplitude), Phase.

Based on these two values, the STFT feature provides two display modes:

- STFT-AMP – shows the time-varying amplitude spectrum
- STFT-PHASE – shows the time-varying phase spectrum

The STFT-AMP mode is displayed as a 3-dimensional view, illustrating how the signal's spectral amplitude changes over time.

In STFT Amp mode, the analyzer must balance **time resolution** and **frequency resolution**. These two values always move in opposite directions: improving time resolution reduces frequency resolution, and improving frequency resolution reduces time resolution.

This behavior is controlled mainly by the **FFT number** (64 to 8K) and the **SPAN** setting (1.8 MHz to 70 MHz). A smaller **FFT number** together with a larger **SPAN** produces a very small **Time Step**, allowing fast time updates and making modulation changes easy to observe. For example, with FFT = 128 and SPAN = 70 MHz, the Time Step is 0.444 μ s, which clearly shows 100 kHz AM or 500 KHz/s ASK signals, it shown on Fig. 24 and 25. In contrast, a larger **FFT number** and smaller **SPAN** improve frequency resolution. The minimum **SPAN** in STFT mode is 1.8 MHz, allowing frequency-variation observation down to about 100 kHz, it shown Fig.22.

The **Time Step** is time resolution (0.22 μ s to 1.1 ms), and the **RBW** is frequency resolution (4.9 MHz to 6.5 kHz). Time visible range will be Time Step* Time Step Number. Frequency range will be SPAN (RBW value will depend on SPAN value and FFT number). The **Time Step Number** only extends the visible time range and does not affect resolution of frequency and time, but it increases sweep time.

Because STFT sweeps can become long, key response may slow down during setup. For easier operation, switch **RUN** to **OFF** while adjusting all parameters, then turn **RUN** back **ON** after setup is complete.

STFT Amp is better for checking OFDM signal with 5M~40M signal bandwidth and other wide band modulation signal.

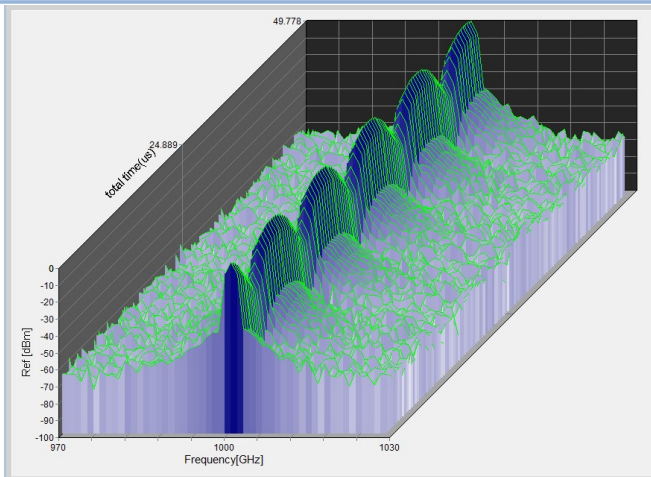


Fig.24 AM signal with Mod frequency 100KHz

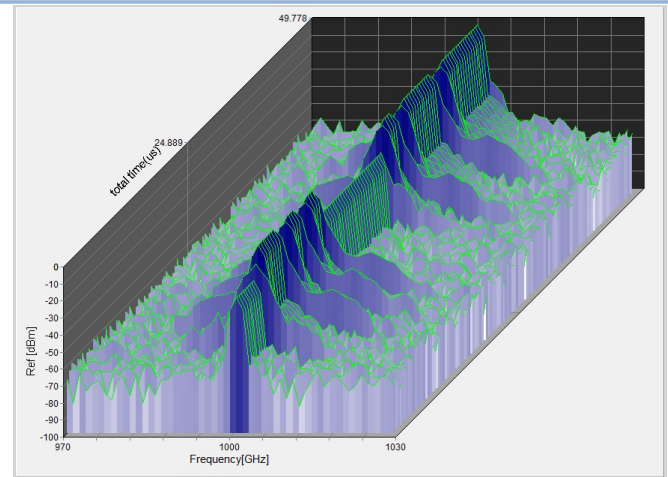


Fig.25 ASK signal with data rate 500KHz/s

3.6.2 STFT phase

The STFT-Phase mode displays the signal's phase information in a 3-dimensional view, showing how the I/Q phase changes over time. While STFT-Amp is useful for studying modulation based on amplitude and frequency, many modern modulation formats are primarily phase-based. STFT-Phase allows these signals to be viewed much more clearly.

Analog PM signals and most digital modulation schemes—such as 4PSK, 8PSK, 16QAM, and 64QAM—encode information through phase changes. By using the FFT phase components, STFT-PHASE makes these phase transitions easy to observe, providing a detailed view of how the modulation is operating. This is especially helpful for analyzing phase-modulated signals and evaluating new communication technologies.

In STFT-PHASE mode, the FFT size is fixed at 64 points to provide finer phase resolution. The **SPAN** setting is used to adjust the **Time Step**, which ranges from 0.22 μ s to 8.6 μ s, allowing the user to select the appropriate time resolution. The **Time Step Number** (11 to 8191) sets the visible time range on the display.

Analog phase-modulated (PM) signals can be directly observed in STFT-PHASE mode. The 3-dimensional phase display shows how the signal's instantaneous phase changes over time, making PM behavior easy to understand. In the example shown in Fig. 26, the test PM signal uses a 40% modulation index, meaning one cycle corresponds to a phase swing of approximately 144 degrees.

Digital phase modulation can also be clearly viewed in STFT-PHASE. For instance, a 4PSK signal displays its I and Q waveforms along the X and Y axes, while the Z axis forms the constellation pattern. The resulting 3D trace shows how each symbol transitions in real time, providing an intuitive view of how 4PSK modulation operates. See Fig. 27 for details.

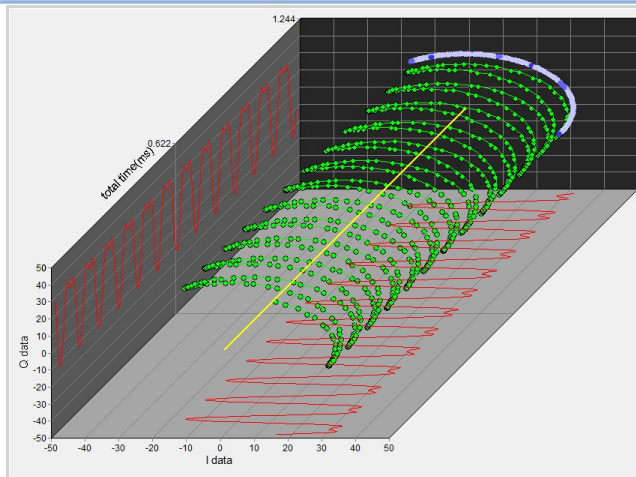


Fig.26 Analog phase-modulated (PM)

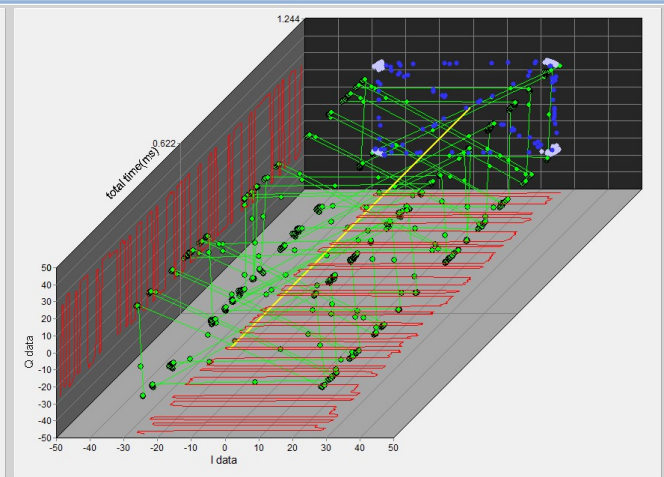


Fig.27 Digital phase modulation 4PSK

3.7 Analog Demodulation

Going into Analog Demodulation have two steps, 1: Select Analog Demodulation at Mode menu, 2: Click Analog Demod key in function keys area. The Analog demodulation menu will be shown on Second function keys.

There are four demodulation mode can be selected:

- AM
- PM
- Zero SPAN
- FM

After going each demodulation mode, first thing needs to do is set RF frequency, set frequency to your test value. Duo to analog demodulation work in time domain, it needs to setup time base parameter, after time base setting, the filter can be fine turn in Filter BW key to get perfect waveform. The trigger key also can be setup to make waveform stable. Just set threshold value to waveform center value.

The time base range for AM, Zero SAPN are from 0.033us~199ms. It is very wide, and test modulation frequency low to 2Hz and high to 30MHz in AM, in the Zero span mode, RF impulse wide can be smaller as to 30ns~50ns, it can be use for most of detector device or radar.

The time base range for PM are from 0.033us~7ms.

The time base range for FM is from 0.0833us to 6.4ms, the deviation range for FM is from 1KHz to 18MHz.

In the Low band (500KHz ~36MHz), the deviation in FM mode will setup to several band, please select it. It also impact with time base range. The time base range in AM, PM and Zero SPAN also setup into several band, and need to select it. Total time based range will be smaller than HB.

3.7.1 AM Demodulation

When go into AM test mode, default time base is 100us, it will show 10 sin waves when modulation frequency is 10KHz. Low as 2Hz modulation frequency can be tested, see Fig.28.

The AM index can be calculated by SIN waveform center value V_c and amplitude V_{pp} , the $I_m = V_{pp} / (2 * V_c) \%$.

The AM test mode also can test very fast modulation signal, or some kind of digital amplitude modulation, such as ASK. The Fig.29 AM mode measure ASK signal .

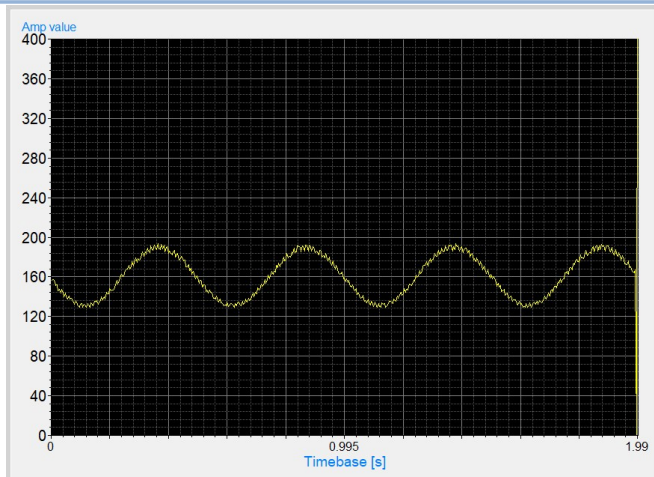


Fig.28 AM mode measure 2Hz mod freq AM signal

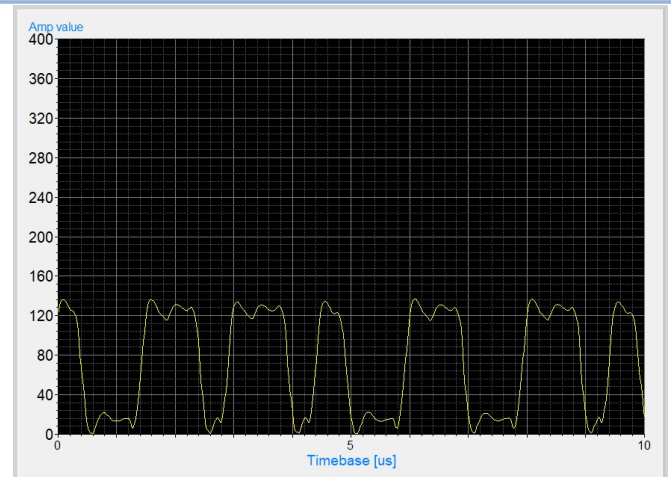


Fig.29 AM mode test 2MSPS ASK signal

3.7.2 PM Demodulation

When go into PM mode, it will be better to setup main clock synchronize with RF signal generator, because any small frequency difference will cause more phase shift.

PM can be used to test standard PM signal, output waveform is SIN wave. Based on PM signal modulation frequency to set time base, it is wide range and be used for normal PM test.

PM mode is also can be used for test Phase modulation signal, such as MSK, 4PSK, 8PSK.....

Fig. 30 is shown the MSK phase waveform, the phase will be linear change 90 degree in each bit. Fig.31 is shown 8PSK phase signal, 8 step of phase level can be seen.

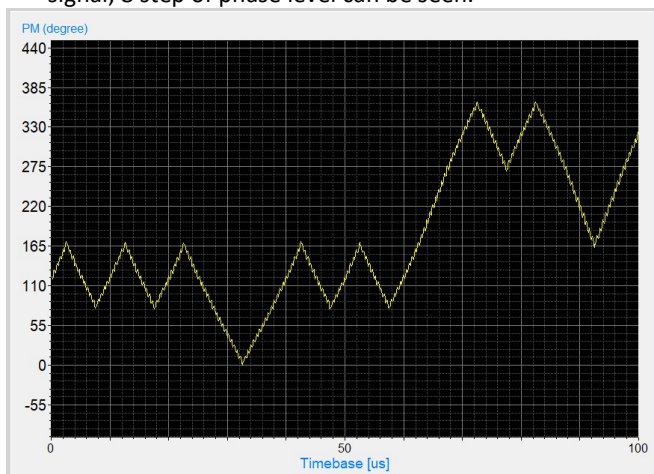


Fig.30 PM mode measure 100kbps MSK signal

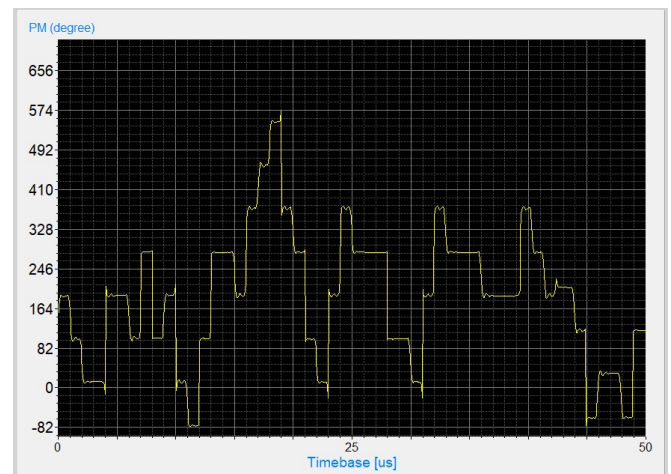


Fig.31 PM mode measure 1Mbps 8PSK signal

3.7.3 Zero SPAN

Zero SPAN is used to measure RF pulse modulation signal. Some spectrum analyzer put Zero span into SPAN functions. But its feature is really familiar to AM demodulation in digital spectrum analyzer. So that Zero span in TRF6G4vsa put into analog demodulation section.



It is very useful to use Zero SPAN to measure RF pulse modulation, because most of RF system are work with pulse modulation, such as TDMA, radar and detector system.

The time base for zero span in TRF6G4vsa is very wide, the pulse width to be measured can be from 1s to 30ns. To fine turn the filter bandwidth can be reduce the noise floor. Fig.32 Zero SPAN mode measure 0.2s pulse width with 1GHz RF signal , Fig.33 Zero SPAN mode measure 1us pulse width with 1GHz RF signal.

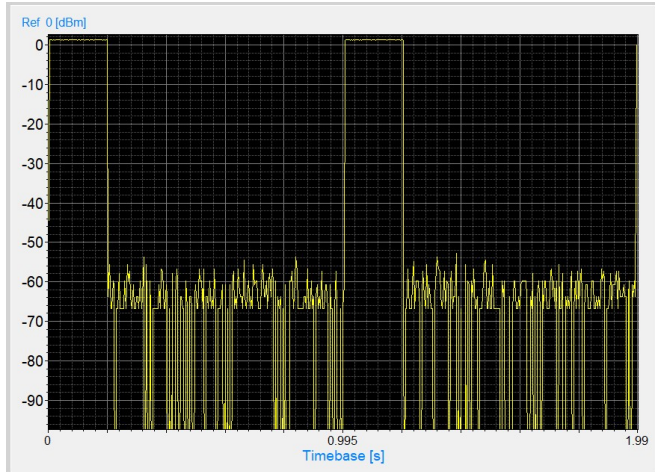


Fig.32 Zero SPAN measure 200ms pulse width signal

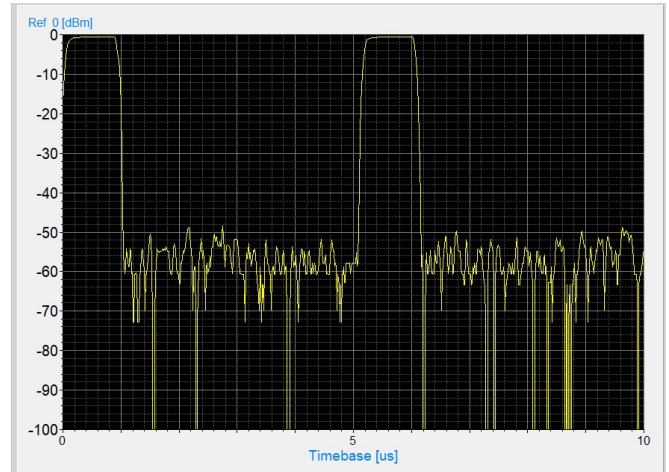


Fig.33 Zero SPAN measure 1us pulse width signal

3.7.4 FM Demodulation

FM measurement need to setup both parameter, time base and deviation. Please note, parameter of deviation value will impact with time base range. For example, deviation set to Maximum 18MHz, the time base range is from 0.0833us to 182us. deviation set to Minimum 1KHz, the time base range is from 1.5ms to 6.4ms.

Due to FM measure range is very wide, it is not only used to measure FM signal. It can used to measure a lot modulation signal based on frequency modulation. Such as FSK, 4FSK, chirp signal and LoRa signal. Fig.34 FM mode measure 2Mbps GMSK signal. Fig.35 FM mode measure 4FSK signal.

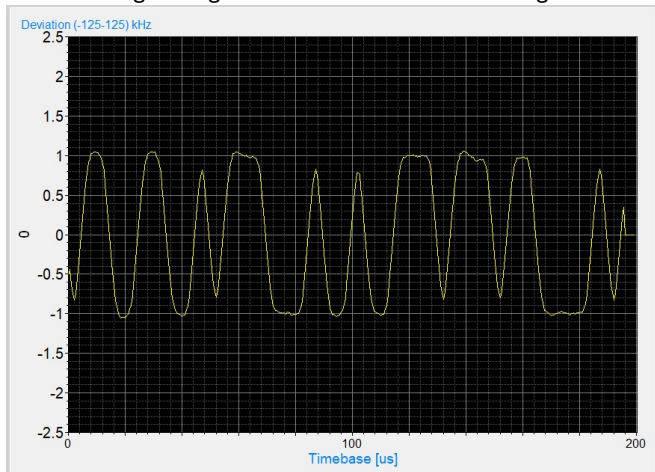


Fig.34 FM mode measure 2Mbps GMSK signal

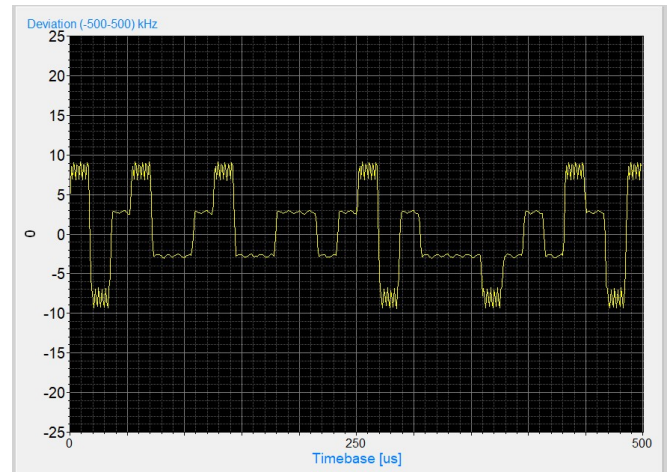


Fig.35 FM mode measure 4FSK signal

3.8 Digital Demodulation

Popular digital modulation is based on amplitude, frequency and phase to work with. The Digital amplitude modulation is ASK, it can be easy to measure by AM or Zero SPAN.



There are many type of digital modulation based on frequency and phase modulation, such as MSK, FSK, GMSK, GFSK, 4FSK, BPSK, QPSK, 8PSK, 16QAM, 64QAM, 256QAM....

Most of spectrum analyzer just list each type of modulation one by one, then find way to demodulated each signal. If one kind of modulation is in the list, it will be not work to demodulate this type of modulation.

TRF6G4vsa try to find common way to work with demodulation, so that two type demodulations will be defined which are:

- Digital frequency demodulation.
- Digital phase demodulation

Most of digital frequency and phase modulation can be work with by TRF6G4vsa, it don't limit to some modulation which must be on the list. Customer can study new kind of modulation. For example, QPSK and 8PSK are common type of modulation, but it is not easy to find 6PSK to be demodulation. TRF6G4vsa can do it.

3.8.1 Digital Frequency Demodulation

Digital frequency demodulation measures signals whose information is encoded through **frequency shifts**. Common modulation types such as **FSK, 4-FSK, GFSK, GMSK, and MSK** can all be analyzed. Even **LoRa**, which uses a wide-band chirp signal (typically around 500 kHz BW) with a linear frequency sweep, can be demodulated in this mode.

To enter **Digital Frequency Demodulation mode**, open the **Mode** menu, select **Digital Demod**, and then choose **Frequency Demod** from the function keypad. The instrument will switch into Digital Frequency Demodulation mode.

Digital frequency demodulation does not require the instrument to know the exact modulation format. It only needs two parameters: the **RF carrier frequency** and the **data rate**. Once these are set, the instrument can demodulate any signal whose modulation is based on frequency deviation.

3.8.1.1 Measurement step for Digital Frequency Demodulation

The first step in Digital Frequency Demodulation is to enter the **data rate** in the digital-frequency menu and ensure that the **RF frequency** matches the actual RF frequency of the measured signal.

The second step is **frequency calibration**. Calibration is required only for frequency modulation which is phase related, such as **MSK** and **GMSK**. Proper calibration ensures accurate phase-related measurements. The instrument supports three calibration methods:

- **Manual calibration:** Disable the modulation on the signal generator so that only the RF carrier is present. Then use the **Frequency** key (or the **Frequency Offset** adjustment in the System menu) to move the carrier to the center of the display. After centering, re-enable modulation.
- **Auto calibration:** After entering the data rate, If the modulation peak is visible and only slightly off-center, click **Cal Frequency** to automatically center it. Note that auto calibration may not work when the data rate is very low (less than 1Mbps) or when the modulation spectrum does not have its maximum amplitude at the center frequency.
- **Clock synchronization:** Synchronize the analyzer's main clock with the signal generator. The TRF6G4vsa accepts a **24 MHz** external clock input, and its clock output ranges from **12 MHz to 100 MHz** with several standard frequency options.

The third step is to begin the digital frequency demodulation measurement. Turn **Demod ON**, then select one of the seven available chart modes using the **Chart** key:

- **Freq Table:** Displays the discrete frequency states of the modulation. FSK shows two points; 4-FSK shows four points. Use **Deviation** to adjust the frequency span and to shift RF **Frequency** value to move point positions. This chart also provides a simple way to perform frequency calibration.
- **FM Waveform:** Shows the instantaneous frequency waveform. FSK appears as a pulse-like waveform, 4-FSK as a stepped waveform, and chirp modulation as a sawtooth-like waveform.
- **Phase Tree (phase-related):** Displays the phase trajectory of the signal. FSK and GMSK often produce a tree-like phase pattern, giving this chart its name.
- **Constellation (phase-related):** For MSK and GMSK, each bit corresponds to a 90-degree phase change. The constellation shows the phase point at the center of each bit interval.
- **EVM (phase-related):** Computes error vector magnitude based on the constellation.
- **Eye Diagram (phase-related):** A commonly used tool for evaluating MSK and GMSK signal quality.
- **I&Q Phase (phase-related):** Displays the I/Q phase trajectory, also useful for MSK and GMSK analysis.



Important: All phase-related charts require proper **frequency calibration**. If the modulation is not phase-based, only **Freq Table** and **FM Waveform** will be applicable.

3.8.1.2 Example for Digital Frequency Demodulation

This example demonstrates how to measure a GMSK signal at 1 GHz with a 200 kbps data rate. Because 200 kbps is relatively low, **auto frequency calibration** may not work reliably, so **manual calibration** is recommended. Begin by generating a **GMSK (BT = 0.7)** signal at **1 GHz** with a **200 kbps** data rate. Turn **off** the modulation so that only the RF carrier is present. Use **FFT Frequency Sweep mode** to measure the carrier's center frequency, then adjust the **Frequency Offset** in the System menu until the peak is centered. In this example, the correct offset is **-238** (see Fig. 36). After calibration, **re-enable modulation** on the RF generator (see Fig. 37). Next, open the **Mode** menu, select **Digital Demod**, and choose **Frequency Demod** to enter Digital Frequency Demodulation mode. Set the **Data Rate** to 200 kHz, and ensure the **Filter Bandwidth (FIR FC)** is set to 600 kHz (three times the data rate). Turn **Demod ON** to begin demodulation.

- Select **Freq Table** in the Chart menu, display will show two frequency points (see Fig. 38). Set **Deviation** to **200 kHz**. Each point will shift by **50 kHz**, which matches the GMSK rule: Deviation = $0.25 \times \text{Data Rate}$.
- Select **FM Waveform** in the Chart menu to view the instantaneous frequency waveform (see Fig. 39). The GMSK waveform will appear smooth due to Gaussian filtering.
- Select **Phase Tree** to observe the phase trajectory (see Fig. 40). Each bit produces a **90-degree phase change**, again shaped by the Gaussian filter.
- Select **Constellation** to display the four GMSK constellation points (see Fig. 41). If the points are not converging cleanly, adjust the frequency slightly until they stabilize.
- Select **EVM** to view both magnitude and phase EVM results (see Fig. 42). Markers show **average**, **minimum**, and **maximum** values.
- Select **Eye Diagram** to display the GMSK eye pattern (see Fig. 43). Changing the eye count will update the display accordingly.
- select **I&Q Phase** to view the I and Q phase trajectories. (see Fig.44)

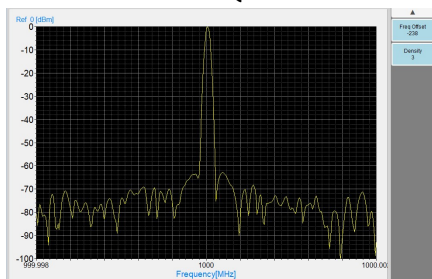


Fig.36 CW Signal to be freq Cal



Fig.37 200Kbps GMSK signal

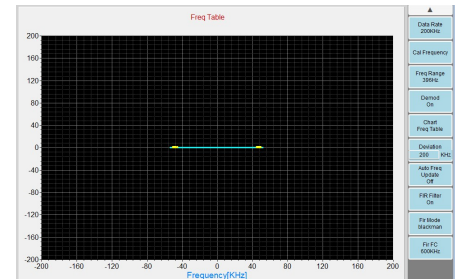


Fig.38 GMSK Freq Table

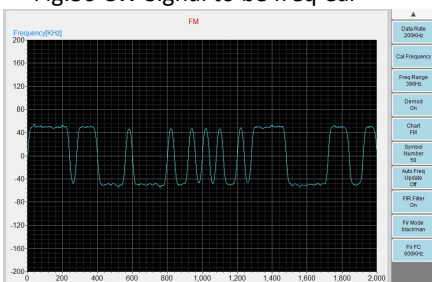


Fig.39 GMSK FM waveform

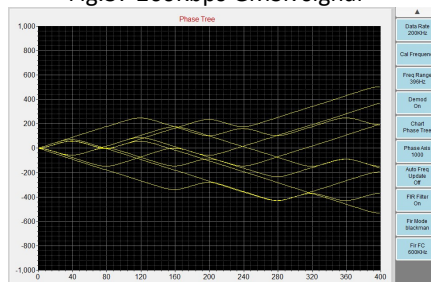


Fig.40 GMSK Phase tree

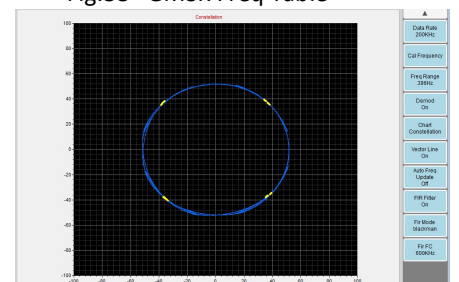


Fig.41 GMSK Constellation

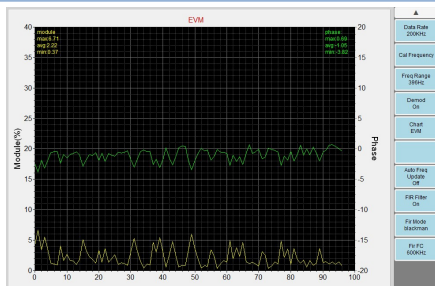


Fig.42 GMSK EVM

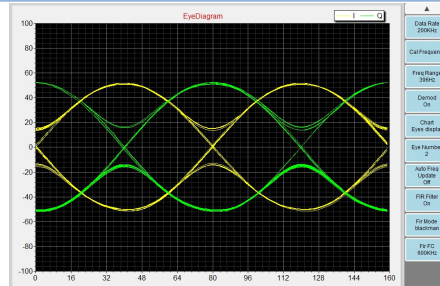


Fig.43 GMSK eyes diagram

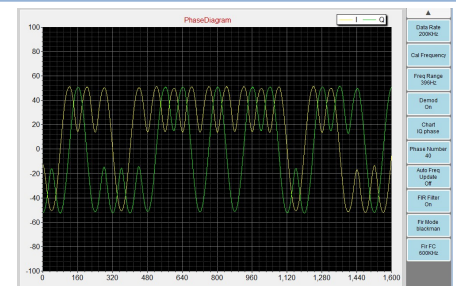


Fig.44 GMSK I&Q phase

3.8.2 Digital Phase Demodulation with I&Q Engine

Digital phase modulation is widely used in modern communication systems. These modulation formats rely on the **I and Q phase components**, along with their amplitude, to define different symbol states. Constellation diagrams are the common way to represent these phase-based modulation schemes.

Because there are many digital phase modulation formats—and new ones continue to appear—it is not practical to maintain a fixed list of supported schemes. Instead, the TRF6G4vsa uses a flexible **I&Q Engine**. This engine allows each modulation format to be defined through an **I&Q Data file**, which describes the constellation points of the modulation.

Once an I&Q file is created, the TRF6G4vsa can demodulate that specific digital phase modulation by following the constellation information in the file. This approach makes it easy to support additional or custom modulation formats. To create an I&Q file, simply define the constellation points for the desired modulation scheme and write them in the I&Q data file format. The instrument will then operate according to that file.

To enter **Digital Phase Demodulation mode**, open the **Mode** menu, select **Digital Demod**, and then choose **Phase Demod** from the function keypad. The instrument will switch into Digital Phase Demodulation mode and begin operating according to the selected I&Q file.

3.8.2.1 Measurement step for Digital Phase Demodulation

The first step in Digital Phase Demodulation is to load the correct **I&Q file** for the modulation format you want to measure. The I&Q file defines the constellation points for that specific digital phase modulation. After loading the file, enter the **data rate** for the signal under test.

The second step is **frequency calibration**. Digital phase demodulation relies entirely on accurate phase information, and any frequency error will directly distort the demodulation results. For this reason, frequency calibration is a critical part of the setup. The instrument supports three calibration methods:

- **Manual calibration:** Disable modulation on the signal generator so that only the RF carrier is present. Use the **Frequency** key or the **Frequency Offset** adjustment in the System menu to move the carrier peak to the center of the display. Once centered, re-enable modulation.
- **Auto calibration:** After entering the data rate, the **Frequency Range** key will show the expected span of frequency calibration. If the modulation peak is visible and only slightly off-center, click **Cal Frequency** to automatically center it. Auto calibration may not work when the data rate is very low or when the modulation spectrum does not have its maximum amplitude at the center frequency.
- **Clock synchronization:** Synchronize the analyzer's main clock with the signal generator. The TRF6G4vsa accepts a **24 MHz** external clock input, and its clock output ranges from **12 MHz to 100 MHz** with several standard frequency options.

The third step is to begin the digital phase demodulation measurement. Turn **Demod ON**, then select one of the four available chart modes using the **Chart** key:

- **Constellation:** Displays the phase constellation defined by the I&Q file. The constellation is best way shown phase modulation scheme.
- **EVM:** Calculates error vector magnitude based on the constellation. Useful for evaluating modulation accuracy.
- **Eye Diagram:** A common tool for checking digital modulation signal quality. Shows bit transitions and timing clarity.



- **I&Q Phase:** Displays the I and Q phase trajectories.

3.8.2.2 Example for Digital Phase Demodulation

This example demonstrates how to measure a **64-QAM** signal at 1 GHz with a 5 Mbps data rate.

Begin by opening the **Mode** menu, selecting **Digital Demod**, then choosing **Phase Demod** to enter the digital phase-demodulation menu. Load the 64-QAM **I&Q file** corresponding to the modulation scheme. Then enter the **Data Rate = 5 Mbps**, and confirm that the **Filter Bandwidth (FIR FC)** is set to **15 MHz** (three times the data rate).

The 64-QAM spectrum will appear (see Fig. 45). At higher data rates such as **5 Mbps**, **auto frequency calibration** works well. Click **Cal Frequency** to perform automatic calibration; the spectrum will shift slightly so that the center peak aligns with the middle of the display (see Fig. 46). If clock synchronization is available, enabling it will further improve measurement stability.

Next, turn **Demod ON** to activate phase demodulation.

- **Constellation:** Select *Constellation* in the Chart menu. All **64 constellation points** will be displayed (see Fig. 47). If the points are not converging cleanly, adjust the frequency slightly until they stabilize.
- **EVM:** Select *EVM* to view both magnitude and phase EVM results (see Fig. 48). Markers show **average**, **minimum**, and **maximum** values.
- **Eye Diagram:** Select *Eyes Diagram* to display the eye pattern (see Fig. 49). Changing the number of eyes will update the display accordingly.
- **I&Q Phase:** Select *I&Q Phase* to view the I and Q phase trajectories (see Fig. 50). This chart helps verify symbol transitions and phase alignment across the 64-QAM constellation.

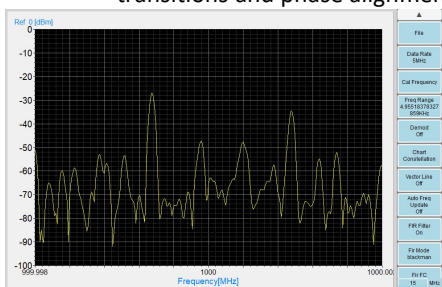


Fig.45 64QAM spectrum

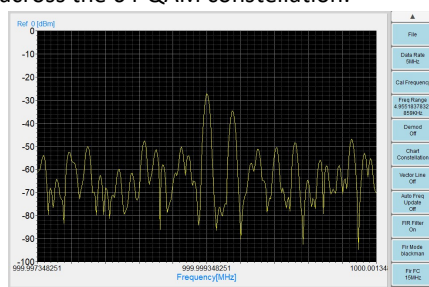


Fig.46 Frequency Calibration

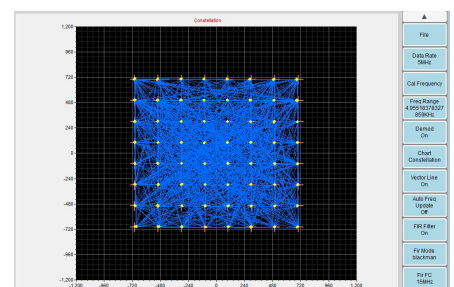


Fig.47 64QAM Constellation

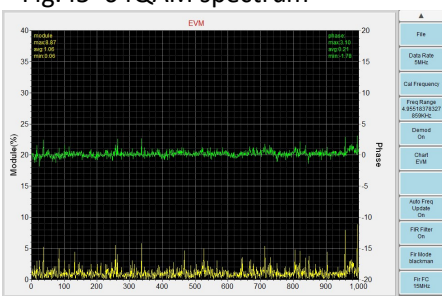


Fig.48 64QAM EVM

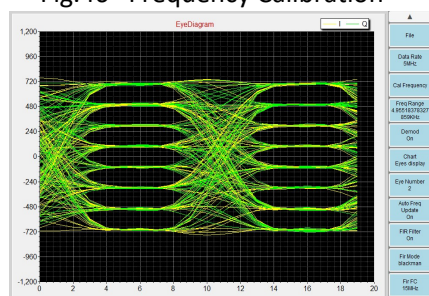


Fig.49 64QAM eyes diagram

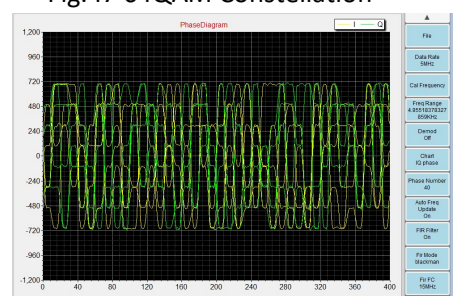


Fig.50 64QAM I&Q phase

3.8.2.3 I&Q engine and I&Q Data file

The **I&Q Engine** generates raw I and Q data based on an **I&Q Data File**. This file is required by the I&Q modulator in the VSG model, and the same file format is used by the spectrum analyzer for phase demodulation.

An I&Q Data File contains four sections, organized as follows:

- Data input



- S/P setting
- converter setting
- I&Q pattern data

QPSK I&Q Data file format will be shown at following:

File	Edit	View
Binary_IN,1,1011000010		
S/P_mode,1,2		
Code_converter,1		
PatternI_00,100		
PatternQ_00,-100		
PatternI_01,100		
PatternQ_01,100		
PatternI_10,-100		
PatternQ_10,-100		
PatternI_11,-100		
PatternQ_11,100		

Fig.51 I&Q Data file

For digital phase demodulation, the TRF6G4vsa uses only the **I&Q Pattern Data** section. This section defines the constellation points that determine the phase modulation format. The **Data Input**, **S/P Setting**, and **Converter Setting** sections are not used during phase digital demodulation.

3.9 Setup connection for RF signal generator

To use the TRF6G4vsa as an **RF Signal Generator**, ensure that the TRF PC Program is already running and connected to the device in **Spectrum Analyzer mode**. The USB connection between the PC and the instrument is established through **USB Area 1**.

Next, go to **USB Area 2**. The device's serial number **CN619000xxx** will appear in the **S/N block**. Click the serial number to activate the RF Signal Generator function. Once connected, the PC user interface will switch to the **RF Signal Generator** display format.

The TRF6G4vsa provides **five RF signal generator modes**, selectable from the **Mode Menu**:

- Single frequency (default setting)
- Sweeping Frequency
- Frequency hopping
- Pulse Modulation
- Amplitude Modulation

3.9.1 Single, sweeping, hopping mode of RF signal generator

After entering the **RF Signal Generator** function, turn **Power ON** to enable RF output. The default output setting is **1 GHz @ 0 dBm**.

Single Frequency Mode

Single Frequency is the default RF generator mode. Set the desired **Frequency** and **Amplitude** directly:

- **Frequency Range:** 1 MHz to 6.4 GHz
- **Amplitude Range:** -70 dBm to **+10 dBm** (up to 3.5 GHz), -70 dBm to **0 dBm** (3.5 GHz to 6.4 GHz)



Sweeping Mode

Sweeping mode is configured through the **Frequency** key. Enter the following parameters:

- **Start Frequency**
- **Stop Frequency**
- **Scan Points**

After entering the parameters, click **Send** to update the settings to the device.

Sweeps may be performed in either:

- **Linear Sweep**
- **Logarithmic Sweep**

Hopping Mode

Hopping mode requires loading a **Hopping File**. The file format is identical to the hopping file used in the spectrum analyzer.

A hopping file contains two items:

- **SPAN Value**
- **Frequency List**

In RF Signal Generator mode, **only the Frequency List is used**. The SPAN value is ignored.

Hopping time is configured under the **Pulse** key.

3.9.2 Pulse and Amp modulation mode of RF signal generator

Pulse Modulation Mode

Pulse modulation is configured under the **Pulse** mode. All pulse-related parameters are set through the **Pulse** key. Pulse modulation can be applied to some RF generator mode, including:

- **Single Frequency**
- **Sweeping Mode**
- **Hopping Mode**

Amplitude Modulation Mode

Amplitude Modulation sweeps the RF output level between two amplitude values. Key characteristics:

- Minimum amplitude level: **-50 dBm**
- Amplitude resolution: **0.25 dB**

3.10 Pulse signal generator

To activate the **Pulse Signal Generator**, select the **Pulse Gen** key and turn **Pulse Gen ON** in the second-function menu. Once enabled, the pulse signal generator becomes active.

The pulse output is provided through the **AUX1** connector. Set the AUX1 port to **TX_PULSE** using the **AUX** key to route the internal pulse source to the AUX1 SMA output.

After the output path is configured, set all required pulse parameters under the **PULSE** key. The instrument will generate the programmed pulse waveform through the AUX1 port.

3.11 Second function of PC program

The **first function** of the PC program provides basic measurement operations directly related to the TRF6G4vsa hardware.

The **second function** performs advanced processing based on the measurement data received from the device. These secondary analysis tools include:

- Marker
- Channel power
- Reference
- Limit line
- Occupied bandwidth
- Average display
- Max display
- Density display
- Waterfall display



These secondary functions allow users to perform more detailed analysis of measurement results, enabling deeper insight into signal characteristics and system performance.

3.12 Trigger function

When a signal includes pulse modulation, its spectrum is affected by the on/off timing of the pulse. Using Trigger Mode ensures that the analyzer captures the signal only during the ON portion of the pulse, providing a correct spectrum display.

- External trigger
- Internal trigger

External trigger requires a trigger signal from an external device. The trigger input port is **AUX1 / RF_Trigger**. Internal trigger uses the **input signal level** itself as the trigger source. For reliable triggering, the input signal level should be **near full scale** or **within 10 dB of full scale**.

3.13 Rear panel and AUX port

The rear panel includes **two AUX ports** and **one USB port**. The **USB port** is used to connect the TRF6G4vsa to a PC and also supplies power to the device.

The **AUX ports** provide interfaces for external clock input/output and trigger signal input/output.

AUX1 port

- CLK_OUT/CLK_Freq: setup output frequency from 12MHz to 100MHz
- TX_Pulse: output TX trigger signal and Pulse generator signal.
- RX_Trigger: input spectrum analyzer input trigger signal.
- DDS_Trigger: Input DDS or VSG trigger signal.
- RAMPCLK: PLL interface for chirp signal, FSK,FM (reserved)
- RAMPDIR: PLL interface for chirp signal, FSK (reserved)
- PHASE_SYNC: PPL phase controller (reserved)

AUX2 port

- CLK_INTERNAL: using internal clock, this pin in also work as Trigger input.
- CLK_IN: when select external clock, this pin will input clock signal, Clock frequency is 24MHz